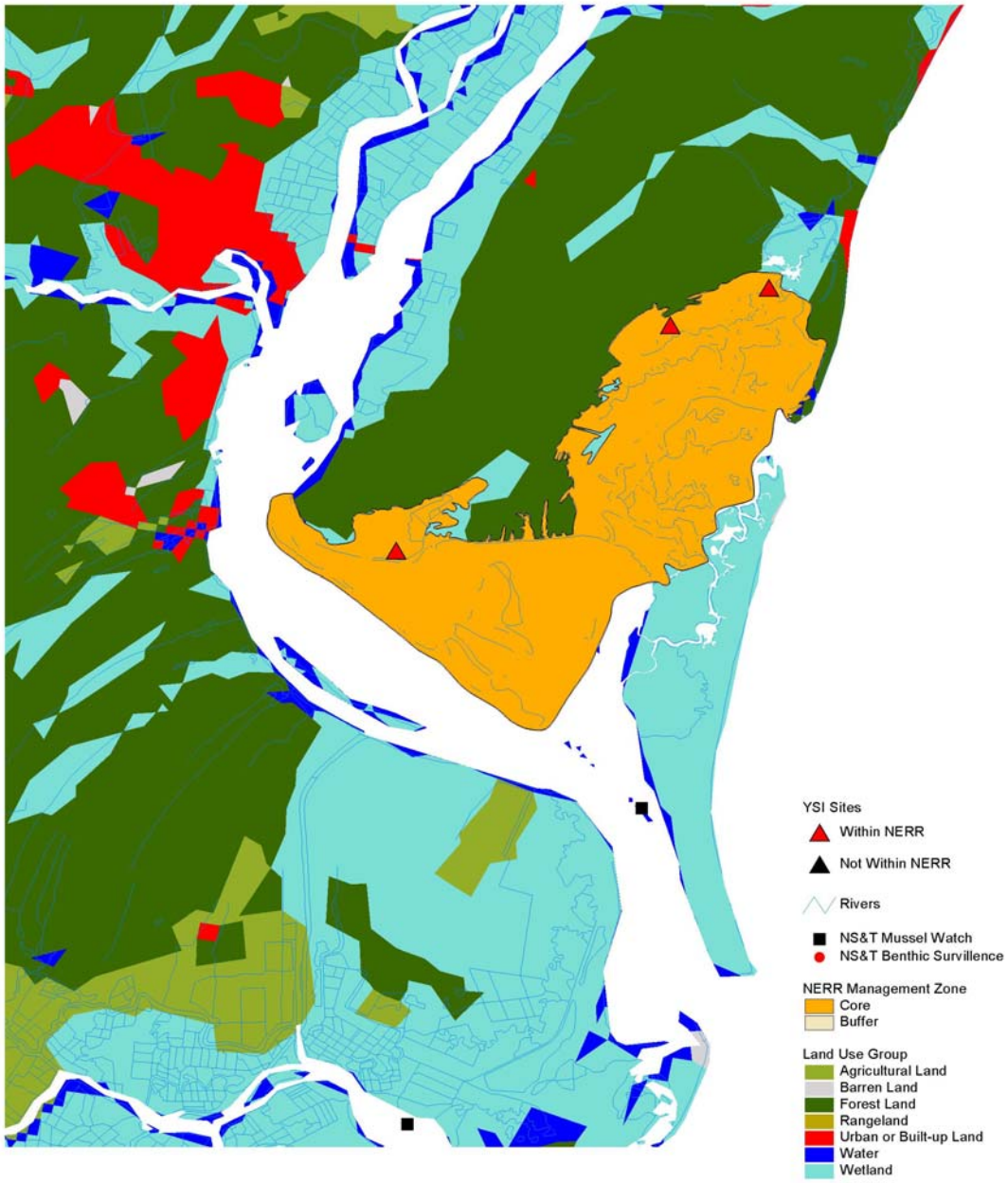
North Inlet – Winyah Bay



North Inlet-Winyah Bay, Oyster Landing (NIWOL)

Characterization (Latitude = 33° 21'03"N; Longitude = 79°11'50" W)
The Oyster Landing site is located at the confluence of Crabhaul Creek and Oyster Landing. Tides are semidiurnal. The length of the water body is ~5.0 km from the headwaters of Crabhaul Creek to the headwaters of Old Man Creek (mainstream linear dimension). The creek has an average depth of ~2 m MHW and an average width of ~150 m. The sampling site is located ~2.8 km from the headwaters of Crabhaul Creek. At the site, creek depth is ~2.1 m (average at MHW) and the width is ~90 m (at MHW). Creek bottom habitats are predominantly oyster shell hash with some fine sediment and detritus, but no bottom vegetation. The dominant marsh vegetation is *Spartina alterniflora*. Crabhaul Creek drains pine forest uplands and wetlands. The Oyster Landing site is part of the North Inlet estuary that is composed of numerous winding tidal creeks and is considered a pristine inlet estuary due to minimal anthropogenic impacts.

Descriptive Statistics
Sixty-seven deployments were made at this site between Jan 1996 and Dec 1998, with equal coverage during all seasons (Figure 129). Mean deployment duration was 13.8 days. Only three deployments (Jul, Oct 1997 and Jan 1998) were less than 10 days.

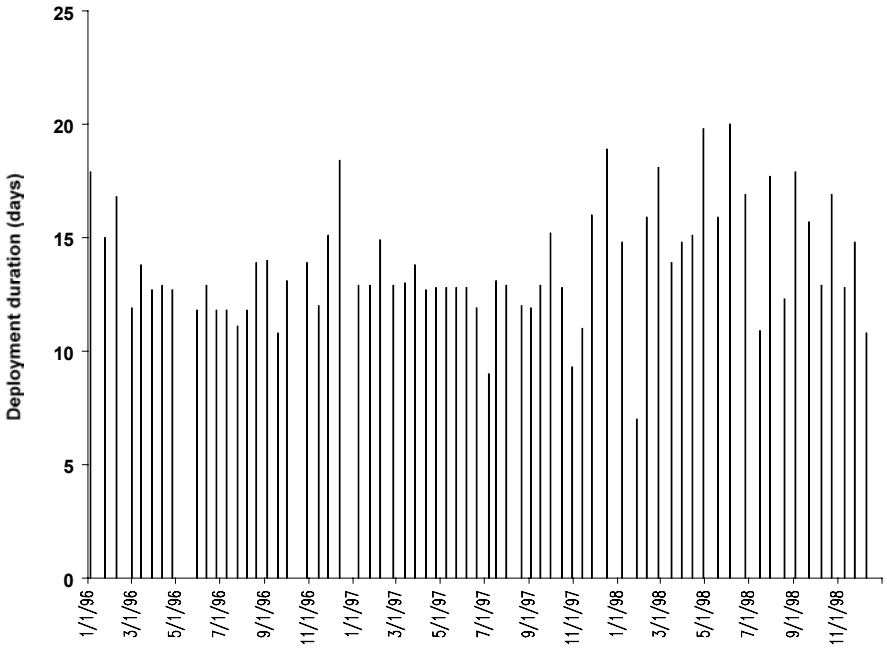


Figure 129. North Inlet-Winyah Bay, Oyster Landing deployments (1996-1998).

Eighty-four percent of annual depth data were included in analyses (79% in 1996, 84% in 1997, and 90% in 1998). Sensors were typically deployed at a depth of 1.5 m below sea level and 0.3 m above the bottom sediment. Strong fluctuations (≥2 m) in depth over daily and bi-weekly cycles were evident from scatter plots, with consistent amplitude throughout the data set. Harmonic regression analysis attributed 76% of depth variance to 12.42 hour cycles, 15% of depth variance to interaction between 12.42 hour and 24 hour cycles, and 9% of depth variance to 24 hour cycles.

Eighty-five percent of annual water temperature data were included in analyses (82% in 1996, 84% in 1997, and 90% in 1998). Water temperature followed a seasonal cycle, with mean water temperatures 9-12°C in winter and 27-29°C in summer (Figure 130). Minimum and maximum water temperatures between 1996-1998 were 1.6°C (Jan 1996) and 34.9°C (Jul 1998), respectively. Scatter plots suggest strong fluctuations (≤ 5°C) in daily water temperature and even stronger fluctuations (5-10°C) in bi-weekly water temperature. Harmonic regression analysis attributed 65% of temperature variance to interaction between 12.42 hour and 24 hour cycles, 21% of temperature variance to 24 hour cycles, and 14% of temperature variance to 12.42 hour cycles.

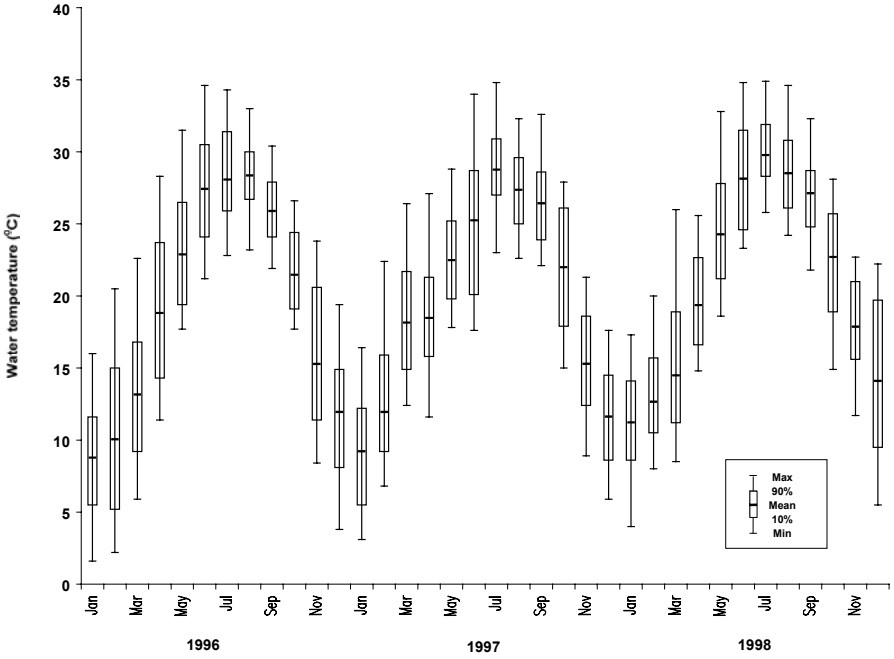


Figure 130. Water temperature statistics at Oyster Landing, 1996-1998.

Eighty percent of annual salinity data were included in analyses (82% in 1996, 84% in 1997, and 75% in 1998). Mean, maximum, and 90th percentile salinity values were typically within 5 ppt of each other (Figure 131). In contrast, mean, minimum, and 10th percentile salinity readings were typically 15-30 ppt different. Maximum salinity regularly exceeded 35 ppt in 1998. Minimum salinity approached 0 ppt in Jul and Sep 1996 and Jan-Mar 1997. Scatter plots suggest strong fluctuation (5-35 ppt) in bi-weekly salinity in all seasons. Harmonic regression analysis attributed 53% of salinity variance to 12.42 hour cycles, 26% of salinity variance to 24 hour cycles, and 21% of salinity variance to interaction between 12.42 hour and 24 hour cycles.

Seventy-nine percent of annual dissolved oxygen (% saturation) data were included in analyses (79% in 1996, 70% in 1997, and 89% in 1998). Mean DO was typically 50-100% saturation, with greatest DO (90-100% sat) in winter and least DO (50-85% sat) in summer. Minimum and maximum DO between 1996-1998 was 0.1% saturation (Jul 1997) and 489.1% (May 1997), respectively. Hypoxia was observed in five months (Jul, Sep 1997 and May, Jul, Aug 1998) and, when present, persisted for 10% of the first 48 hours post-deployment on average (Figure 132). Supersaturation was regularly observed in 1996 and 1997 and, when present, supersaturation persisted for 13.8% of the first 48 hours post-deployment (1996-1997) on average. Scatter plots suggest moderate to strong fluctuation (20-

80%) in daily and bi-weekly percent saturation during all seasons, with very strong fluctuation (> 100%) during episodic events in May and Aug 1996, May-Jul 1997, Mar 1998, and Jul-Sep 1998. Harmonic regression analysis attributed 62% of DO variance to interaction between 12.42 hour and 24 hour cycles, 21% of DO variance to 24 hour cycles and 17% of DO variance to 12.42 hour cycles.

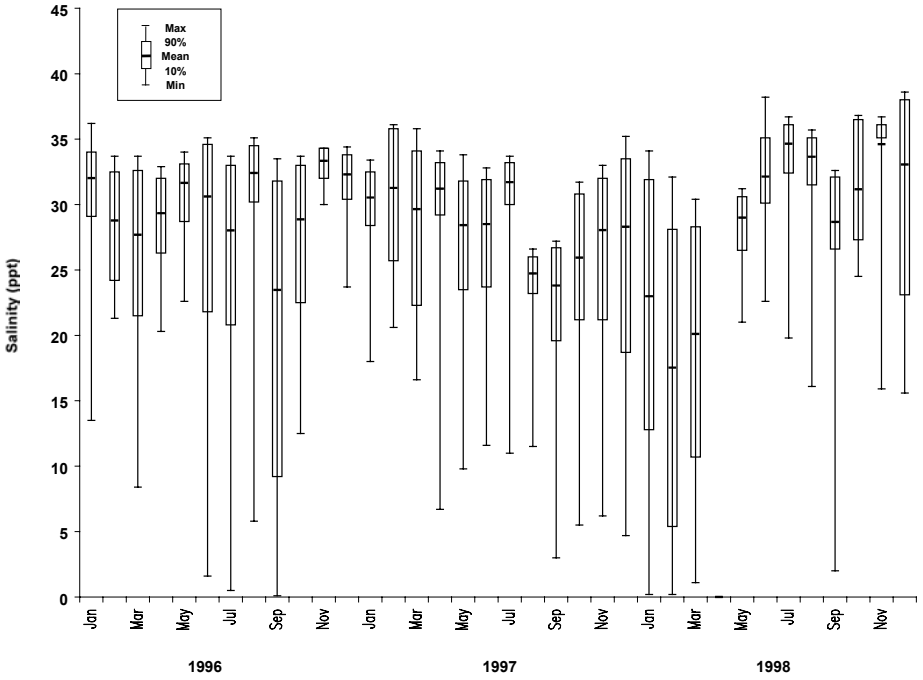


Figure 131. Salinity statistics at Oyster Landing, 1996-1998.

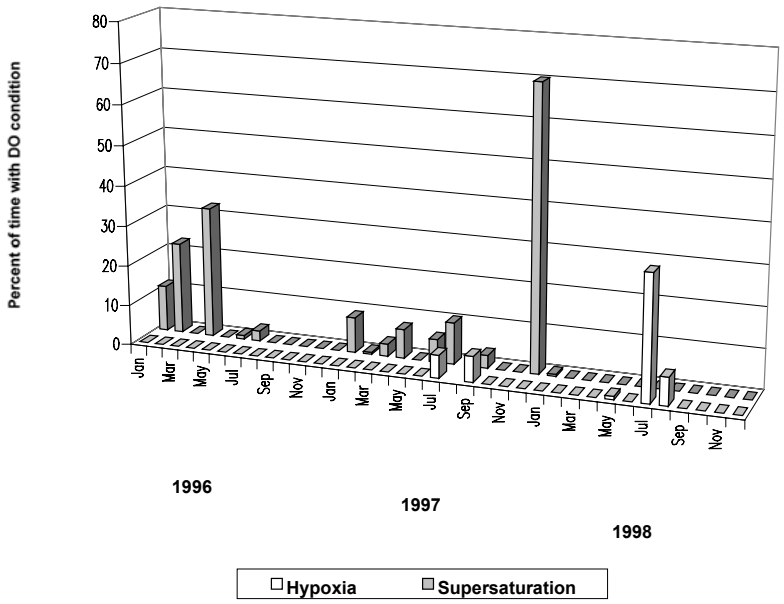


Figure 132. Dissolved oxygen extremes at Oyster Landing, 1996-1998.

Photosynthesis/Respiration

Over four fifths (88%) of the data used to calculate the metabolic rates fit the basic assumption of the method (heterogeneity of water masses moving past the sensor) and were used to estimate net production, gross production, total respiration and net ecosystem metabolism (Table 28). Instrument drift during the duration of the deployments was not a significant problem at this site. Total respiration exceeded gross production at Oyster Landing; thus, the net ecosystem metabolism and P/R ratio indicated that this is a heterotrophic site (Figure 133). Temperature was significantly ($p<0.05$) correlated with gross production, total respiration and net ecosystem metabolism. Gross production and respiration increased as temperature increased, while net ecosystem metabolism became more heterotrophic as temperature increased. Salinity was significantly ($p<0.05$) correlated with gross production and total respiration. Gross production and total respiration increased as salinity increased. Thus, the metabolic rates generally followed a seasonal pattern with the lowest rates during the winter when temperature and salinity were low and the highest rates during summer months.

Table 28. Summary of metabolism data and statistics at Oyster Landing, 1996-1998.

Oyster Landing	mean	s.e.
Water depth (m)	1.46	
Net production $gO_2/m3/d$	0.84	0.06
Gross production $gO_2/m3/d$	3.63	0.10
Total respiration $gO_2/m3/d$	5.15	0.12
Net ecosystem metabolism g $O_2/m3/d$	-1.53	0.07
Net ecosystem metabolism g C/m2/y	-124	
P/R	0.7	
Statistical results		
Drift – paired t-test		
Gross production	ns	
Total respiration	ns	
Net ecosystem metabolism	ns	
Percent useable observations	88 %	
Paired t-test on gross production and total respiration	$p < 0.001$	
Correlation coefficient	Temperature	Salinity
Gross production	0.47	0.16
Total respiration	0.71	0.16
Net ecosystem metabolism	-0.53	ns

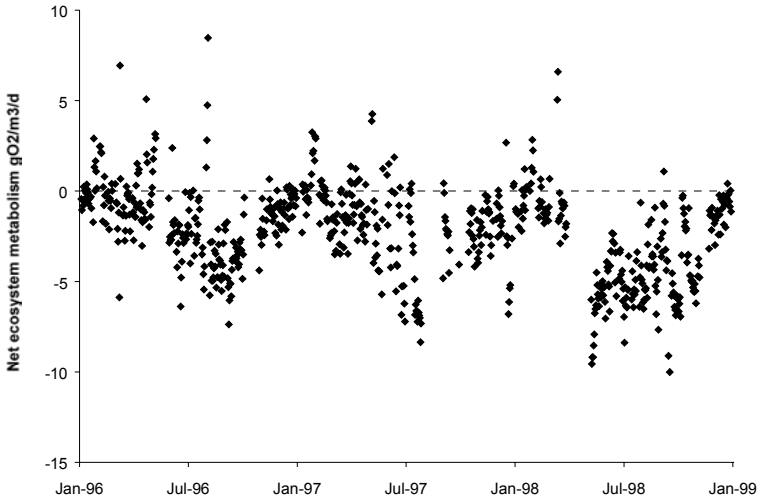


Figure 133. Net metabolism at Oyster Landing, 1996-1998.

North Inlet-Winyah Bay, Thousand Acre (NIWTA)

Characterization (Latitude = 33°18'02"N; Longitude = 79°15'4"W)
Tides at Thousand Acre are semidiurnal. The water body is ~1.5 km long (mainstream linear dimension), has an average depth of ~2.5 m, and an average width of ~8 m MHW. This monitoring site is located in a tidal creek at Thousand Acre marsh. The YSI was deployed approximately 30 m NE of the west bridge of Thousand Acre marsh, about 15 m from the mouth of the creek. The creek empties into the northeastern side of the middle portion of Winyah Bay. At the sampling site, creek depth is approximately 2 m MHW and creek width is approximately 10 m. Creek bottom habitats are predominantly fine sediments and detritus with no bottom vegetation. The dominant marsh vegetation near this site is *Spartina cynosuroides* and the dominant upland vegetation is pine forest. Georgetown, located 5 km upstream from the Thousand Acre site on the southern side of Winyah Bay, is the home port for a number of heavy industries including a steel plant, paper mill, chemical plant, and a coal-fired power plant. A sewage treatment plant that discharges into the bay is also located in Georgetown.

Descriptive Statistics
Sixty-five deployments were made at this site between Jan 1996 and Dec 1998, with equal coverage during all seasons (Figure 134). Mean deployment duration was 14.2 days. Only one deployment (May 1997) was less than 10 days.

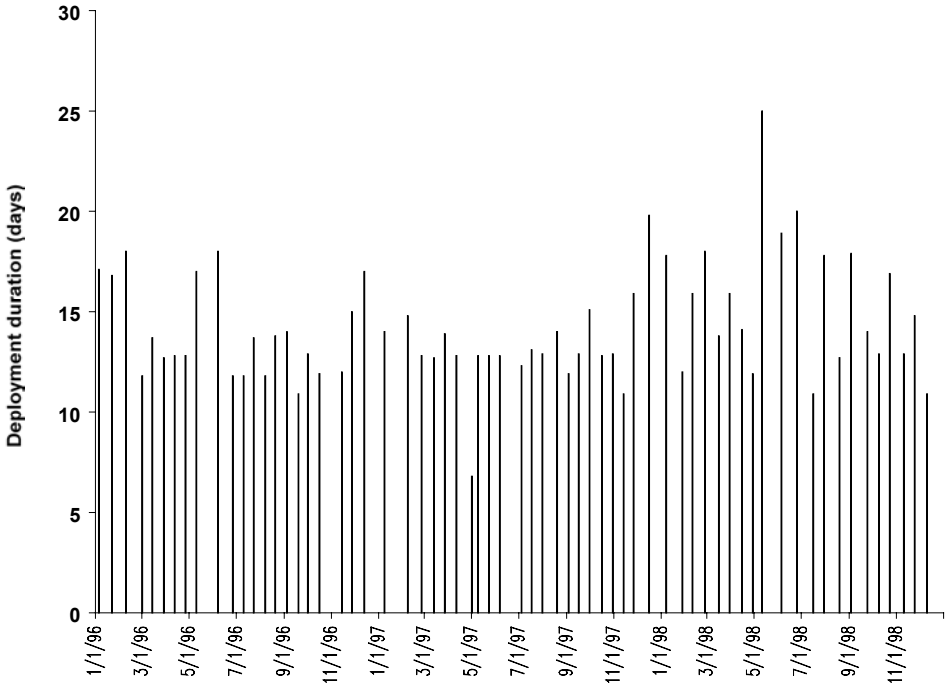


Figure 134. North Inlet-Winyah Bay, Thousand Acre deployments (1996-1998).

Eighty-five percent of annual depth data were included in analyses (84% in 1996, 79% in 1997, and 93% in 1998). Sensors were deployed at a mean depth of 1.2 m below the water surface and 0.3 m above the bottom sediment. Scatter plots suggest strong fluctuations (1.5-2 m) in daily and bi-weekly depth, with consistent amplitude in all seasons. Harmonic regression analysis attributed 83% of depth

variance to 12.42 hour cycles, 10% of depth variance to interaction between 12.42 hour and 24 hour cycles, and 7% of depth variance to 24 hour cycles.

Eighty-five percent of annual water temperature data were included in analyses (84% in 1996, 79% in 1997, and 93% in 1998). Water temperature followed a seasonal cycle, with mean water temperatures 7-10°C in winter (1996, 1997) and 26-29°C in summer (Figure 135). Minimum and maximum water temperatures between 1996-1998 were 0.4°C (Feb 1996) and 36°C (Jul 1998), respectively. Scatter plots suggest strong fluctuations (≤ 10°C) in daily water temperature and even stronger fluctuations (≤ 15°C) in bi-weekly water temperatures during spring. Throughout the remainder of the year, daily and bi-weekly fluctuations were ≤ 5°C and ≤ 10°C, respectively. Harmonic regression analysis attributed 53% of temperature variance to interaction between 12.42 hour and 24 hour cycles, 35% of variance to 24 hour cycles, and 12% of variance to 12.42 hour cycles.

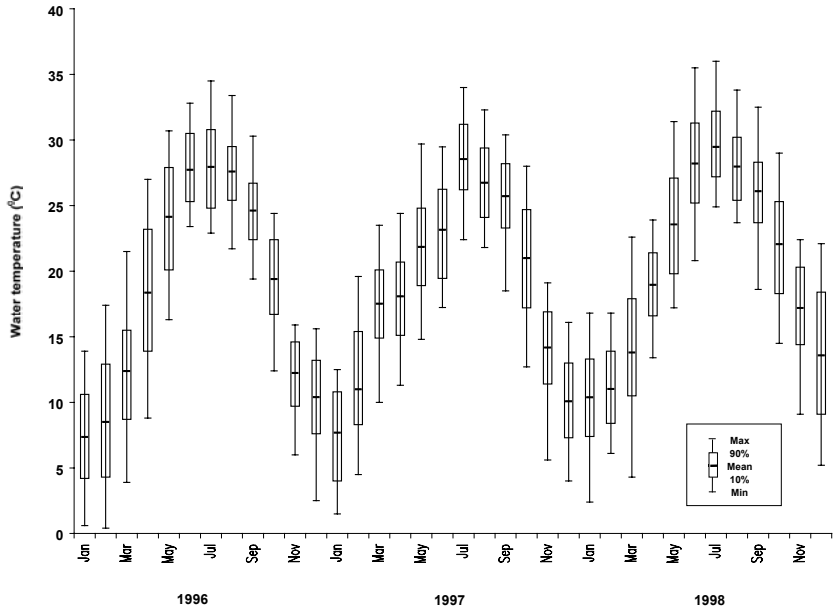


Figure 135. Water temperature statistics at Thousand Acre, 1996-1998.

Eighty-four percent of annual salinity data were included in analyses (84% in 1996, 79% in 1997, and 89% in 1998). Salinity followed a seasonal cycle, with mean salinity <5 ppt in winter, spring, and fall (except Nov 1996) and > 5 ppt in summer (Figure 136). Mean summer salinity in summer 1996-1997 was 5-10 ppt less than mean summer salinity in 1998. Mean salinity in fall 1998 remained elevated at 10-15 ppt, rather than decreasing to < 5 ppt as was the case in 1996-1997. Minimum salinity regularly approached 0 ppt in 1996-1997 and winter 1998. Maximum salinity between 1996-1998 was 33.4 ppt (Sep 1997). Scatter plots suggest strong (5-10 ppt) fluctuation in daily and bi-weekly salinity throughout most of the data set, with stronger (≥ 20 ppt) fluctuations during episodic events in Jul 1996 (Hurricane Bertha), Sep 1997, and Jul 1998. Harmonic regression analysis attributed 52% of salinity variance to 12.42 hour cycles, 29% of salinity variance to interaction between 12.42 hour and 24 hour cycles, and 19% of salinity variance to 24 hour cycles.

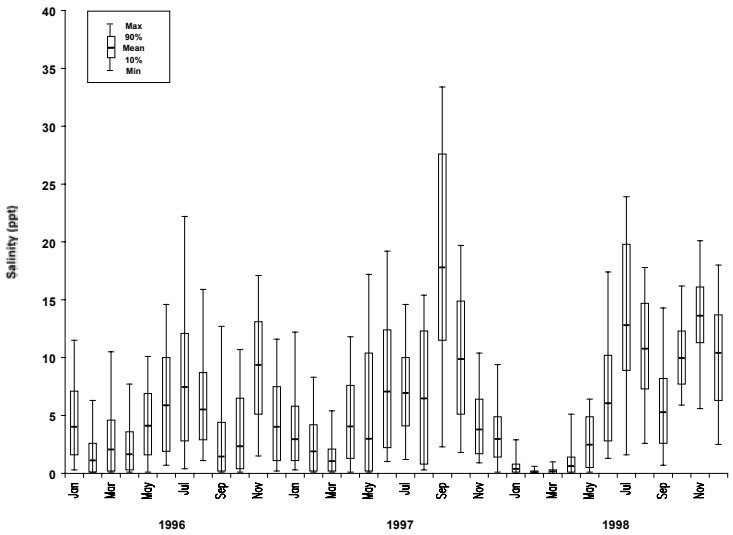


Figure 136. Salinity statistics at Thousand Acre, 1996-1998.

Seventy-seven percent of annual dissolved oxygen (% saturation) data were included in analyses (76% in 1996, 75% in 1997, and 79% in 1998). Mean DO was typically 50-100% saturation and followed a seasonal cycle. Mean DO was lowest in summer (50-85%, except Aug 1998) and greatest in winter (85-100%). Minimum and maximum DO between 1996-1998 was 0% saturation (Jul 1997) and 390.7% saturation (Aug 1998), respectively. Hypoxia was observed in the summer and, when present, hypoxia persisted for 12% of the first 48 hours post-deployment on average (Figure 137). Supersaturation was observed in the spring and summer and, when present, supersaturation persisted for 4% of the first 48 hours post-deployment on average. Scatter plots suggest moderate fluctuations (20-60%) in percent saturation over daily and bi-weekly intervals, with strong fluctuations (≥ 100%) during episodic events in summer. Harmonic regression analysis attributed 42% of DO variance to 12.42 hour cycles, 40% of DO variance to interaction between 12.42 hour and 24 hour cycles, and 20% of DO variance to 24 hour cycles.

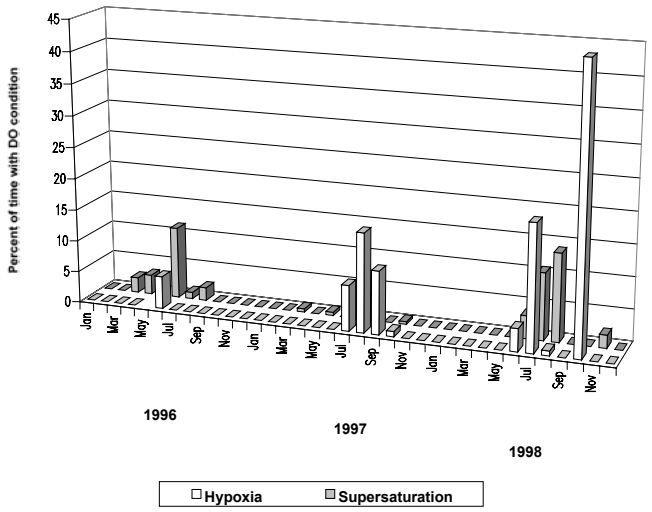


Figure 137. Dissolved oxygen extremes at Thousand Acre, 1996-1998.

Photosynthesis/Respiration

Nearly three quarters (73%) of the data used to calculate the metabolic rates fit the basic assumption of the method (heterogeneity of water masses moving past the sensor) and were used to estimate net production, gross production, total respiration and net ecosystem metabolism (Table 29). Instrument drift during the duration of the deployments was not a significant problem at this site. Total respiration exceeded gross production at Thousand Acre Creek; thus, the net ecosystem metabolism and P/R ratio indicated that this is a very heterotrophic site (Figure 138). Temperature was significantly ($p<0.05$) correlated with gross production, total respiration and net ecosystem metabolism. Gross production and respiration increased as temperature increased, while net ecosystem metabolism became more heterotrophic as temperature increased. Salinity was significantly ($p<0.05$) correlated with gross production, total respiration, and net ecosystem metabolism. Gross production and total respiration increased as salinity increased, while net ecosystem metabolism became more heterotrophic as salinity increased. Thus, the metabolic rates generally followed a seasonal pattern with the lowest rates during the winter when temperature and salinity were low and the highest rates during summer months, although summer rates could be highly variable.

Table 29. Summary of metabolism data and statistics at Thousand Acre Creek, 1996-1998.

Thousand Acre Creek	mean	s.e.
Water depth (m)	1.23	
Net production $gO_2/m3/d$	0.11	0.08
Gross production $gO_2/m3/d$	2.74	0.13
Total respiration $gO_2/m3/d$	5.05	0.16
Net ecosystem metabolism g $O_2/m3/d$	-2.31	0.09
Net ecosystem metabolism g C/m2/y	-274	
P/R	0.54	
Statistical results		
Drift – paired t-test		
Gross production	ns	
Total respiration	ns	
Net ecosystem metabolism	ns	
Percent useable observations	73 %	
Paired t-test on gross production and total respiration	$p < 0.001$	
Correlation coefficient	Temperature	Salinity
Gross production	0.44	0.29
Total respiration	0.56	0.37
Net ecosystem metabolism	-0.34	-0.24